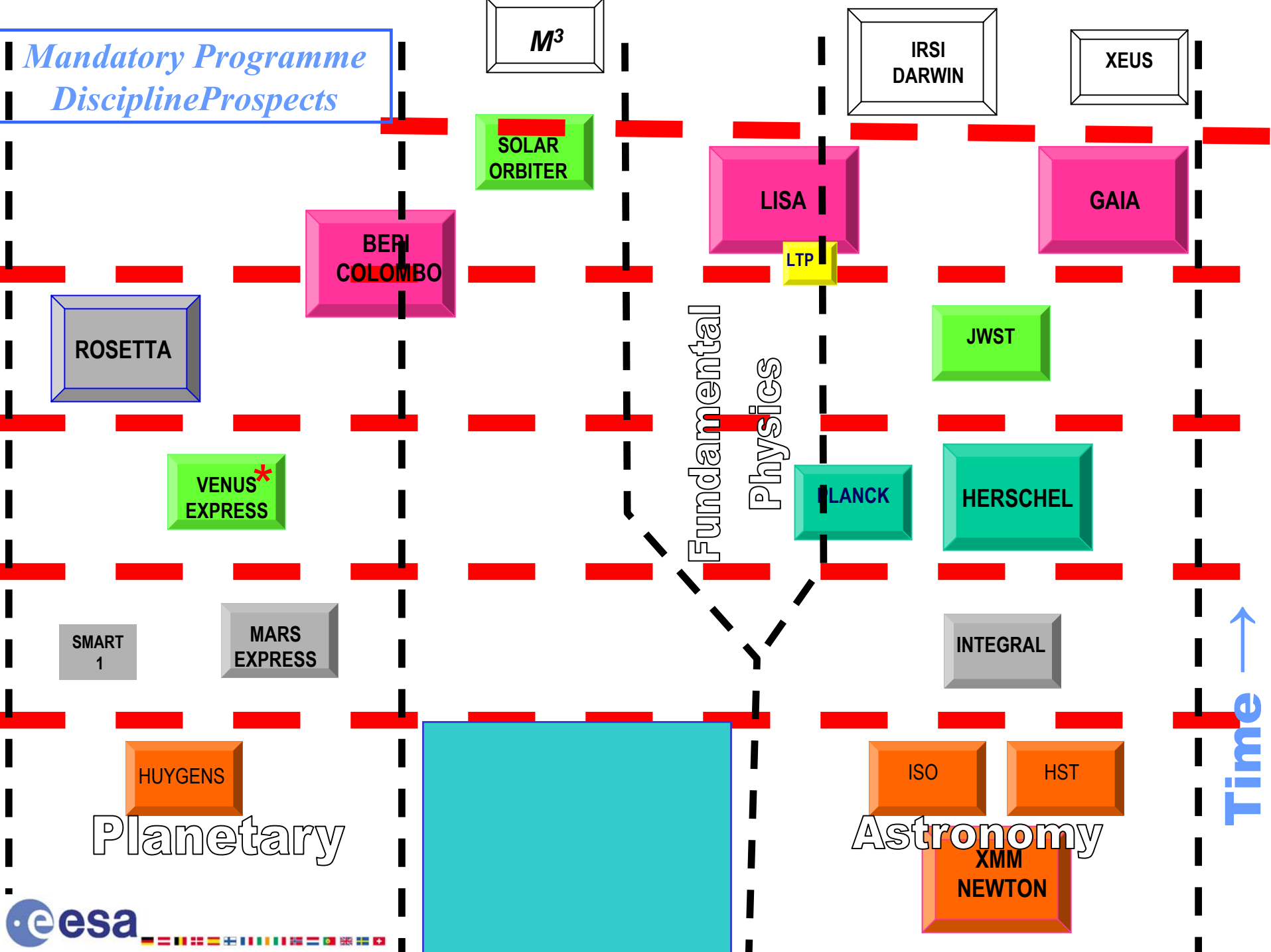
Space Plasma Missions in the Science Programme of ESA

ILWS Update April 2005

Hermann J. Opgenoorth

ESA – ESTEC
Solar and Solar Terrestrial Missions Division (SCI-SH)
Research and Scientific Support Department (RSSD)

Hermann.Opgenoorth@esa.int


Mandatory Programme
DisciplineProspects
M3
IRSI
DARWIN
XEUS
SOLAR
ORBITER
LISA
GAIA
BERI
COLOMBO
LTP
ROSETTA
JWST
Fundamental
Physics
VENUS
EXPRESS
LANCK
HERSCHEL
SMART
1
MARS
EXPRESS
INTEGRAL
Time
HUYGENS
ISO
HST
Planetary
Astronomy
XMM
NEWTON
esa

Mission Status

In Orbit:

Ulysses Mission extension for third Polar pass decided by ESA

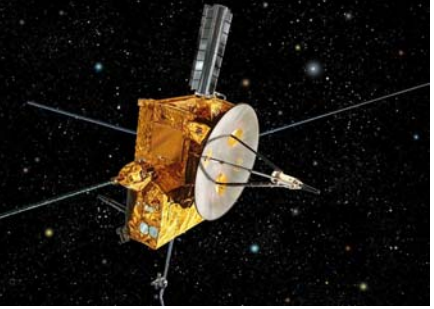
Sept 2004 - March 2008, NASA decision pending

SOHO

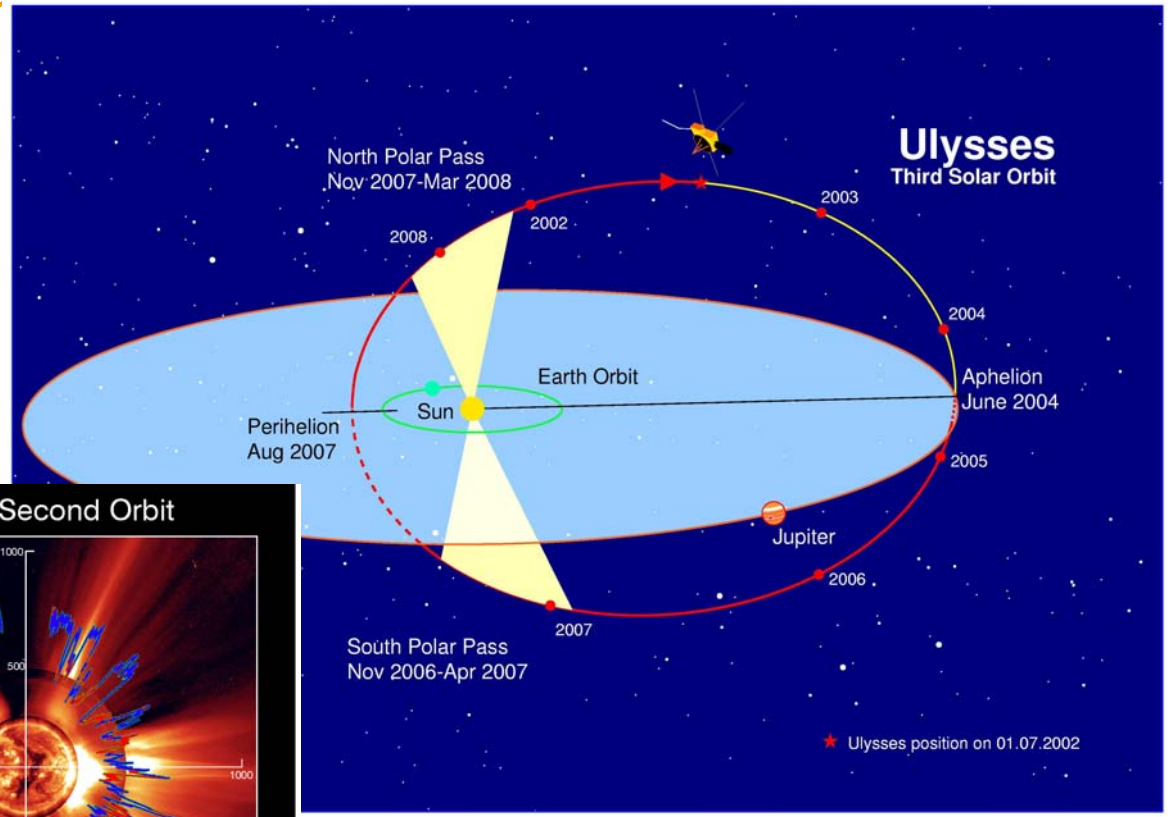
Cluster

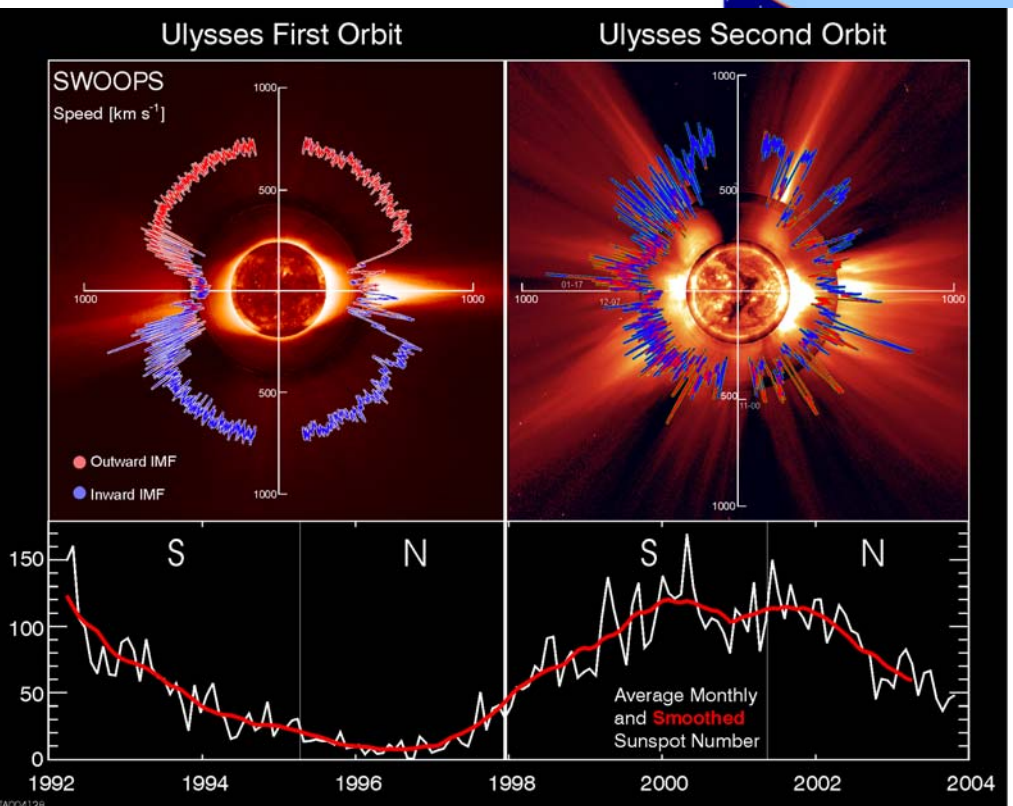
Double Star

Hermann.Opgenoorth@esa.int



Ulysses





the Context of Extension:

dust dynamics: effect of
on latitude dependence
uth heliospheric asymmetry
and heliospheric current
th ecliptic S/C like STEREO

Mission Status

In Orbit:

Ulysses

Mission extension for third Polar pass decided by ESA

Sept 2004 - March 2008, NASA decision pending

SOHO

Mission nominal, keyhole operations not problematic, at present

Science case for mission extension 2007-2009 unproblematic

Further mission extension on basis of "SOHO-BONUS" concept,

=> operate Coronagraph and TSI in support of SDO/ILWS a.l.a.p.

Cluster

Double Star

Hermann.Opgenoorth@esa.int

Mission Status

In Orbit:

Ulysses

Mission extension for third Polar pass decided by ESA

Sept 2004 - March 2008, NASA decision pending

SOHO

Mission nominal, keyhole operations not problematic, at present

Science case for mission extension 2007-2009 unproblematic

Further mission extension on basis of "SOHO-BONUS" concept,

=> operate Coronagraph and TSI in support of SDO/ILWS a.l.a.p.

Cluster

Mission extension decided for Jan 2006 - Dec 2009 (2+2 years)

New configuration scenario & new orbit development (more below)

Double Star

Hermann.Opgenoorth@esa.int

Mission Status

In Orbit:

Ulysses Mission extension for third Polar pass decided by ESA
Sept 2004 - March 2008, NASA decision pending

SOHO Mission nominal, keyhole operations not problematic, at present
Science case for mission extension 2007-2009 unproblematic
Further mission extension on basis of "SOHO-BONUS" concept,
=> operate Coronagraph and TSI in support of SDO/ILWS a.l.a.p.

Cluster Mission extension decided for Jan 2006 - Dec 2009 (2+2 years)
New configuration scenario & new orbit development (more below)

Double Star 1, respectively 1.5 year mission extension under assessment
more coordination with Cluster, new orbit configurations give
alignment in magnetotail and conjunctions at dayside magnetopause

Hermann.Opgenoorth@esa.int

Mission Status

In Preparation

Bepi Colombo

Payload selection completed.

B-C MPO and MMO now complementary in plasma terms

Industrial tender action in preparation

Solar Orbiter

SWARM

Hermann.Opgenoorth@esa.int

Payload Comparison (Plasma & Waves)

Instrument	BC/MPO	BC/MMO	Messenger
Energetic neutral particle analyzer	✓	✓	
Energetic particle & ion analyzer		✓	✓
Ion mass spectrum analyzer		✓	
Electron analyzer		✓	
Magnetometer	✓	✓	✓
Electric field instrument		✓	
Plasma wave instrument		✓	
Search coil		✓	

- Bepi Colombo MMO will be the first fully equipped plasma mission to Mercury
- BC MPO & MMO constitute the first multi-satellite visit to another magnetosphere

Mission Status

In Preparation

Bepi Colombo

Payload selection completed.

B-C MPO and MMO now complementary in plasma terms

Industrial tender action in preparation

Solar Orbiter

Science definition and payload definition completed.

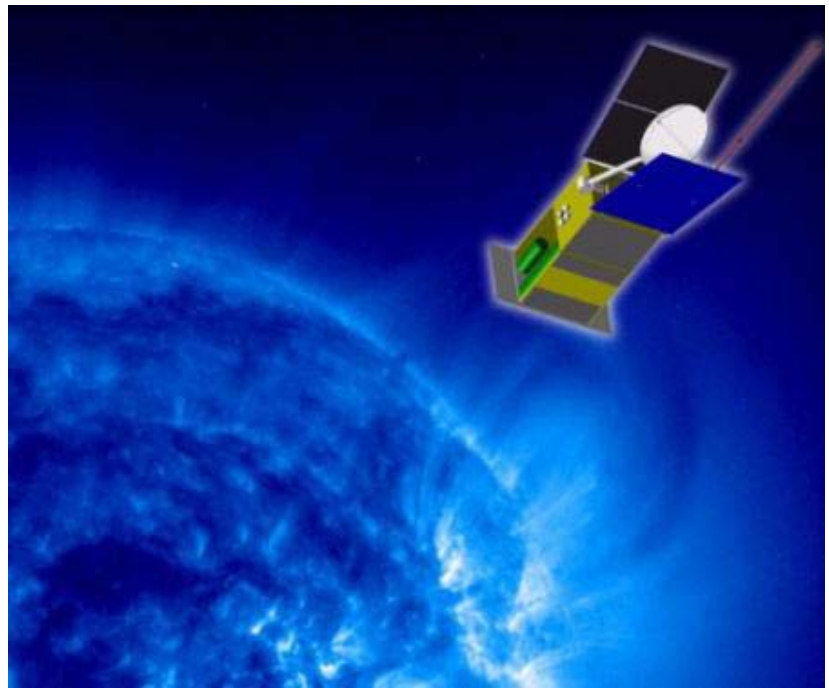
Assessment phase basically completed, but delta-study still pending.

SWARM

Hermann.Opgenoorth@esa.int

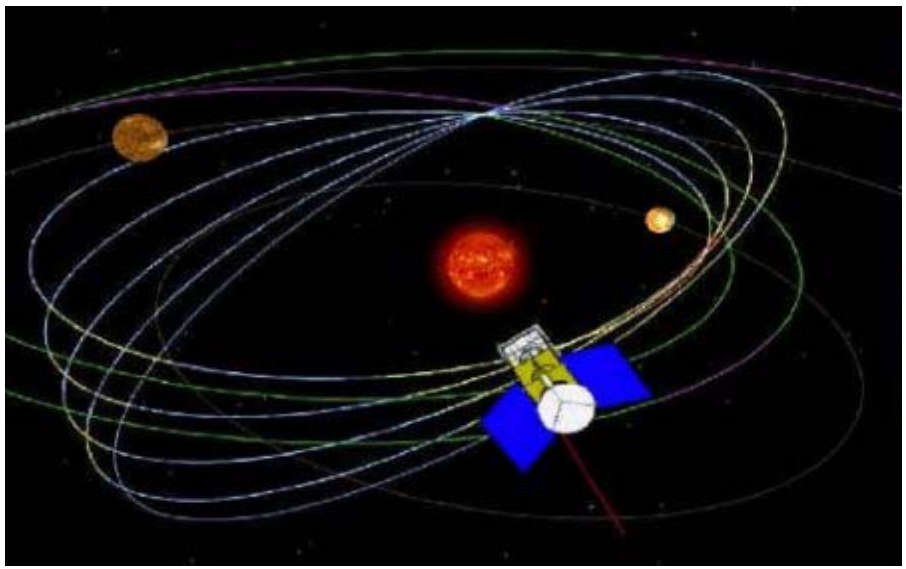
Solar Orbiter

ESA-ILWS Flagship in the long term



- **Selected as ESA Flexi-mission**
- **launched within 10 yrs - lifetime 5 + 2 yrs**
- **confirmed as part of "COSMIC VISION"**

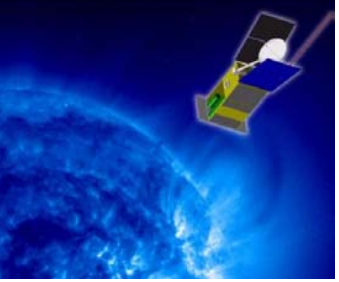
- **Formal negotiations about a potential NASA contribution (or collaboration with Solar Sentinels) recently initiated**



- **Inner Heliosphere In-Situ observations and simultaneous Solar Remote Sensing**

- **Orbit up to 35 deg out of the ecliptic, i.e. topside view of polar regions and CME's**

- **observe the far-side of the Sun from a co-rotating vantage point at 0.22 AU, equivalent to 48 Solar radii…**



Solar Orbiter Status

Confirmed as part of Cosmic Vision by SPC in June 2004

Mission profile:

- Launch by Soyuz-Fregat 2-1b (either Oct 2013 or March 2015)
- Cruise phase (Solar Electric Propulsion): 1.5 yrs
- Nominal mission duration: 4.6 yrs
- Extended mission (high-latitude phase): 2.4 yrs
- Minimum perihelion distance: 48 solar radii (0.222 AU)
- Maximum solar latitude: 35° (in extended phase)

SPACECRAFT – two industrial studies completed
– 6 month delta-study initiated (Sci-A)

PAYLOAD – definition completed
Particles and Fields Package
Remote-sensing Package

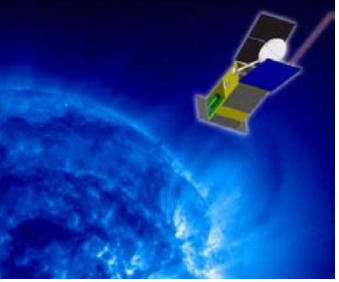


Table 1-1: Solar Orbiter model payload instruments

Instrument	Acronym	Contact Person
Solar Wind Plasma Analyzer	SWA	McComas
Radio and Plasma Wave Analyzer	RPW	S.Bale
Radio Sounding	CRS	Passive instrument
Magnetometer	MAG	C.Carr
Energetic Particle Detector	EPD	H.Kunow
Dust Detector	DUD	I.Mann
Neutral Particle Detector	NPD	Hilchenbach
Neutron Detector	NGD	Barraclough
Visible Imager and Magnetograph	VIM	Valentin Martinez
EUV Imager and Spectrometer	EUS	R.Harrison
EUV Imager	EUI	J.-M.Defise
UV Coronograph	UVC	Fineschi
Radiometer	RAD	I.Ruedi
Spectrometer/Telescope Imaging X-rays	STIX	Hurford
Heliospheric Imager	HI	Korendyke

Mission Status

In Preparation

Bepi Colombo

Payload selection completed.
B-C MPO and MMO now complementary in plasma terms
Industrial tender action in preparation

Solar Orbiter

Science definition and payload definition completed.
Assessment phase basically completed, but delta-study still pending.

SWARM

Nominal progress, industrial tender action planned for autumn
Ion drift instrument (electric field instr.) under study in Canada,
- technical feasibility to be demonstrated before autumn
Draft science case for addition electron spectrometer delivered
- discussions to be finalised before summer.
Launch 2009

Hermann.Opgenoorth@esa.int

Mission Status

Other activities:

CAA Nominal progress, Implementation review in May 2005
First year of Cluster data public by autumn,
then 2 years of data per year

Solar - B

European Data

Cosmic Vision

Hermann.Opgenoorth@esa.int

Mission Status

Other activities:

CAA — Nominal progress, Implementation review in May 2005
First year of Cluster data public by autumn,
then 2 years of data per year

Solar - B — Contractual activities delayed, but no change of plan
ground-station and database in Norway

European Data

Cosmic Vision

Hermann.Opgenoorth@esa.int

Mission Status

Other activities:

CAA Nominal progress, Implementation review in May 2005
First year of Cluster data public by autumn,
then 2 years of data per year

Solar - B Contractual activities delayed, but no change of plan
ground-station and database in Norway

European Data EU application for European SVO support,
other activities planned for later this year.

Cosmic Vision

Hermann.Opgenoorth@esa.int

Mission Status

Other activities:

CAA Nominal progress, Implementation review in May 2005
First year of Cluster data public by autumn,
then 2 years of data per year

Solar - B Contractual activities delayed, but no change of plan
ground-station and database in Norway

European Data EU application for European SVO support,
other activities planned for later this year.

Cosmic Vision ESLAB last week in ESTEC
General discussion of trends and themes, M^3 high on priority list
Final document ready for presentation to SSAC (May 2)
and SPC May 9/10 in Helsinki.

Hermann.Opgenoorth@esa.int

ESA Cosmic Vision 2015-2025

Messages from Community to SSWG

- **Go Outward!** Explore the outer Solar System
  (Jupiter, Europa, and beyond)
- **Look at Small Scales!** Understand Space Plasmas
  (Magnetospheres, Heliosphere & Solar magnetic fields)
- **Seek Ground Truth!** Land on NEOs, Moons, Planets
  (Look below surface and return samples)
- **Look for Life!**
  Everywhere in the Solar System

Hermann.Opgenoorth@esa.int

ESA Cosmic Vision 2015-2025

SSWG Recommendations

- SSWG identified 3 themes, each with 3 topics + 1 outlook
  1. From Sun to Earth and Beyond: the Plasma Universe
  2. Tracing the Origin of the Solar System
  3. Life and Habitability in the Solar System and Beyond
- With 4 cross-theme favorites in community:
  1. Multi-scale Fleet (electron scale, ion scale, and more)
  2. Jupiter, Europa, and beyond
  3. Sample return from minor bodies
  4. Subsurface Mars and other bodies

Hermann.Opgenoorth@esa.int

In the meantime…

Second Cluster Extension

Key rationale for extension

- ***Mission extension: Jan 2006 – Dec 2009 (2+2 years)***
  - need to explore also the **polar cusp/solar wind at large (10000 km) s/c separation**
  - start a new s/c configuration phase allowing for **adaptive** or **multi-scale/multi-orientation observations** and
  - visit **new magnetospheric key regions,** never visited by multi-spacecraft missions before

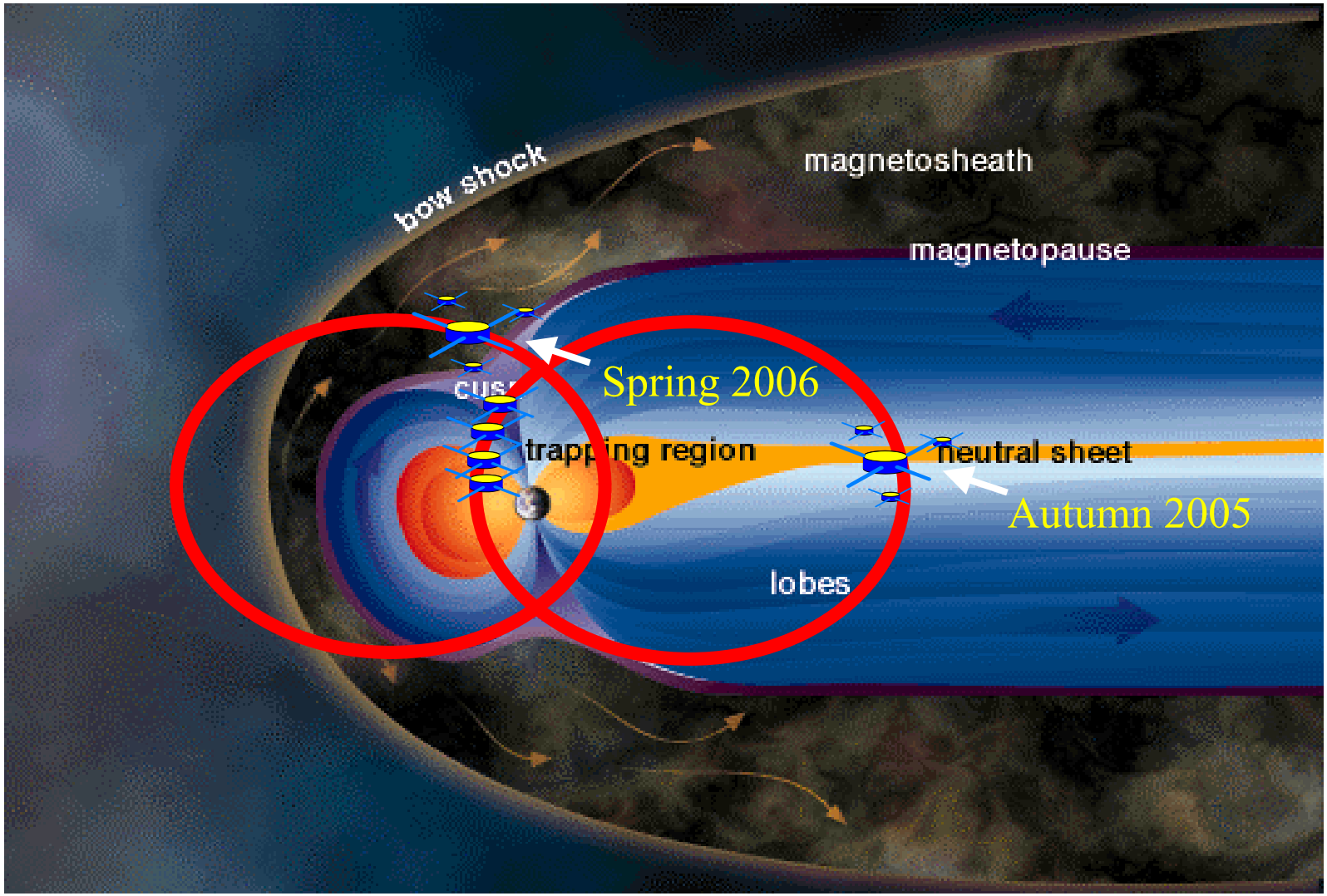
In the meantime…

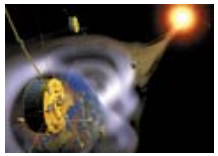
Second Cluster Extension

Key rationale for extension

- ***Mission extension: Jan 2006 – Dec 2009 (2+2 years)***
  - need to explore also the **polar cusp/solar wind at large (10000 km) s/c separation**
  - start a new s/c configuration phase allowing for **adaptive** or **multi-scale/multi-orientation observations** and
  - visit **new magnetospheric key regions,** never visited by multi-spacecraft missions before

Large separations in Tail and Mid-Altitude Cusp (2005), High-Altitude Cusp (2006)

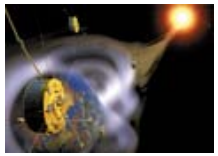




Key rationale for extension

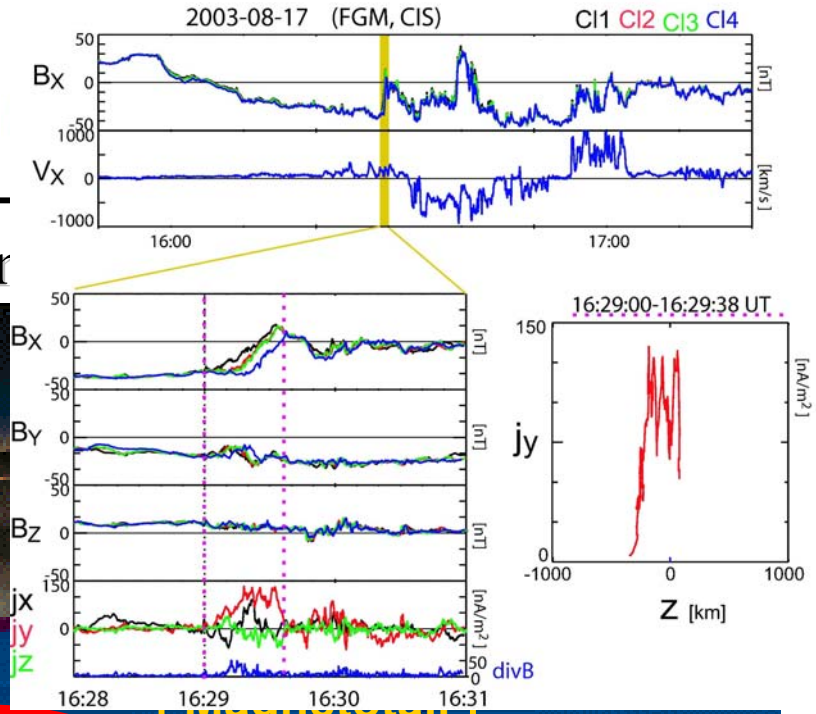
- *Mission extension: Jan 2006 – Dec 2009 (2+2 years)*
  - need to explore also the **polar cusp/solar wind at large (10000 km) s/c separation**
  - start a new s/c configuration phase allowing for **adaptive** or **multi-scale/multi-orientation observations**
  - visit **new magnetospheric key regions,** never visited by multi-spacecraft missions (Cluster) before

Hermann.Opgenoorth@esa.int

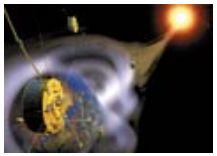


CLUSTER

Cluster at multi-scales/r

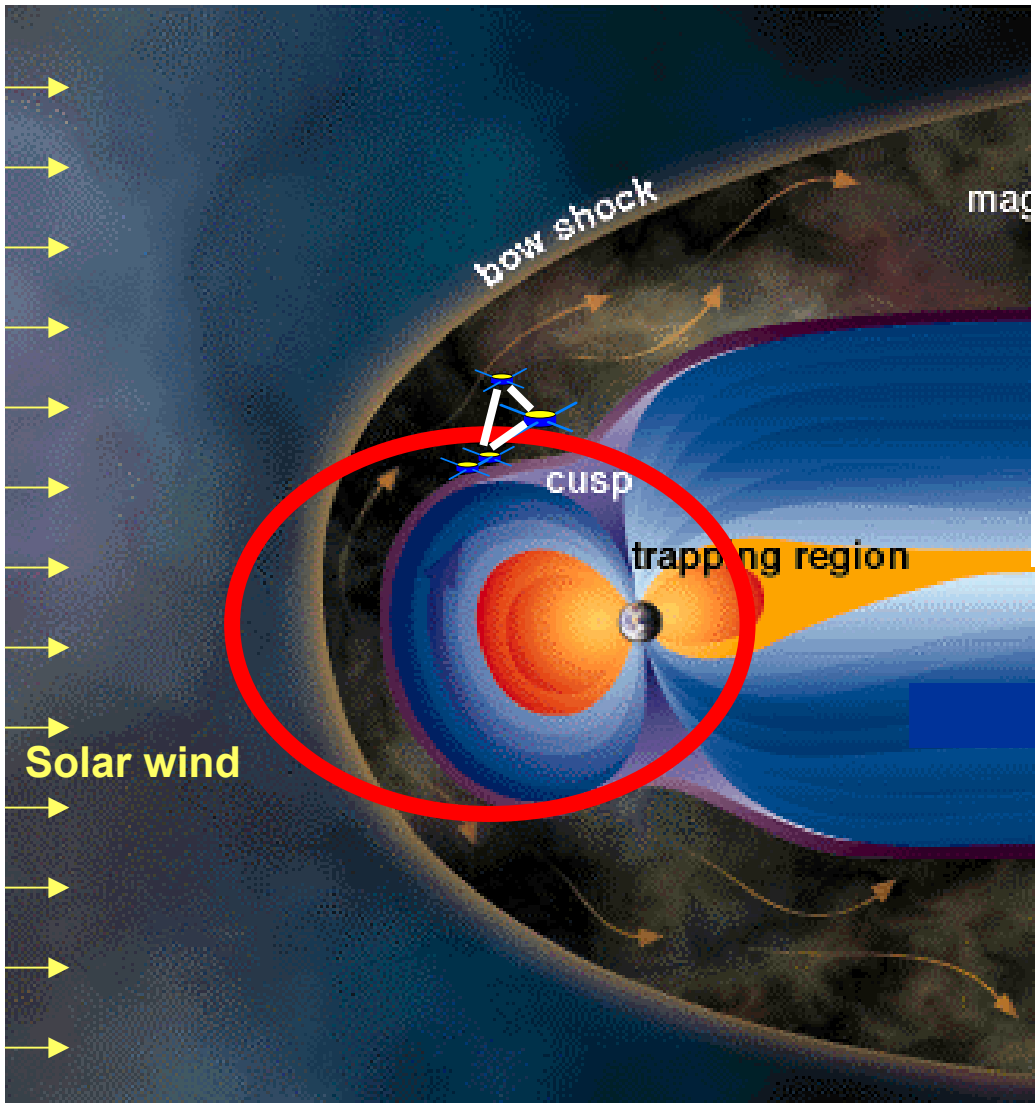


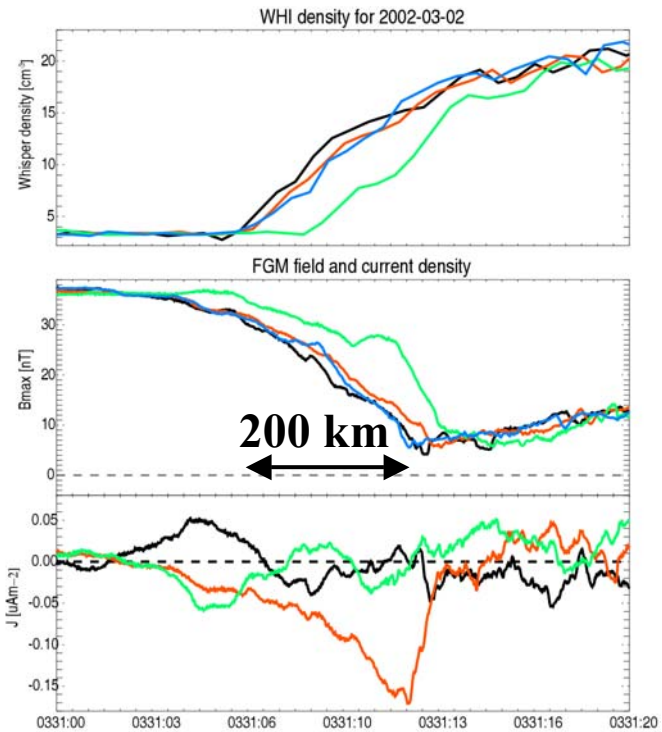
- Phase change between C3 and C4 (0.1 kg fuel)
- Large scale along and across neutral sheet
- Small scale in Z



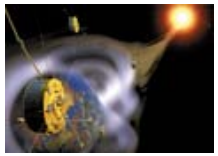
CLUSTER

Cluster multi-scales/multi-orientation: m





- Phase change of C2 and C1 => triangle // bow shock, magnetopause
- Large scale along and across bow shock and magnetopause
- Small scale along normal

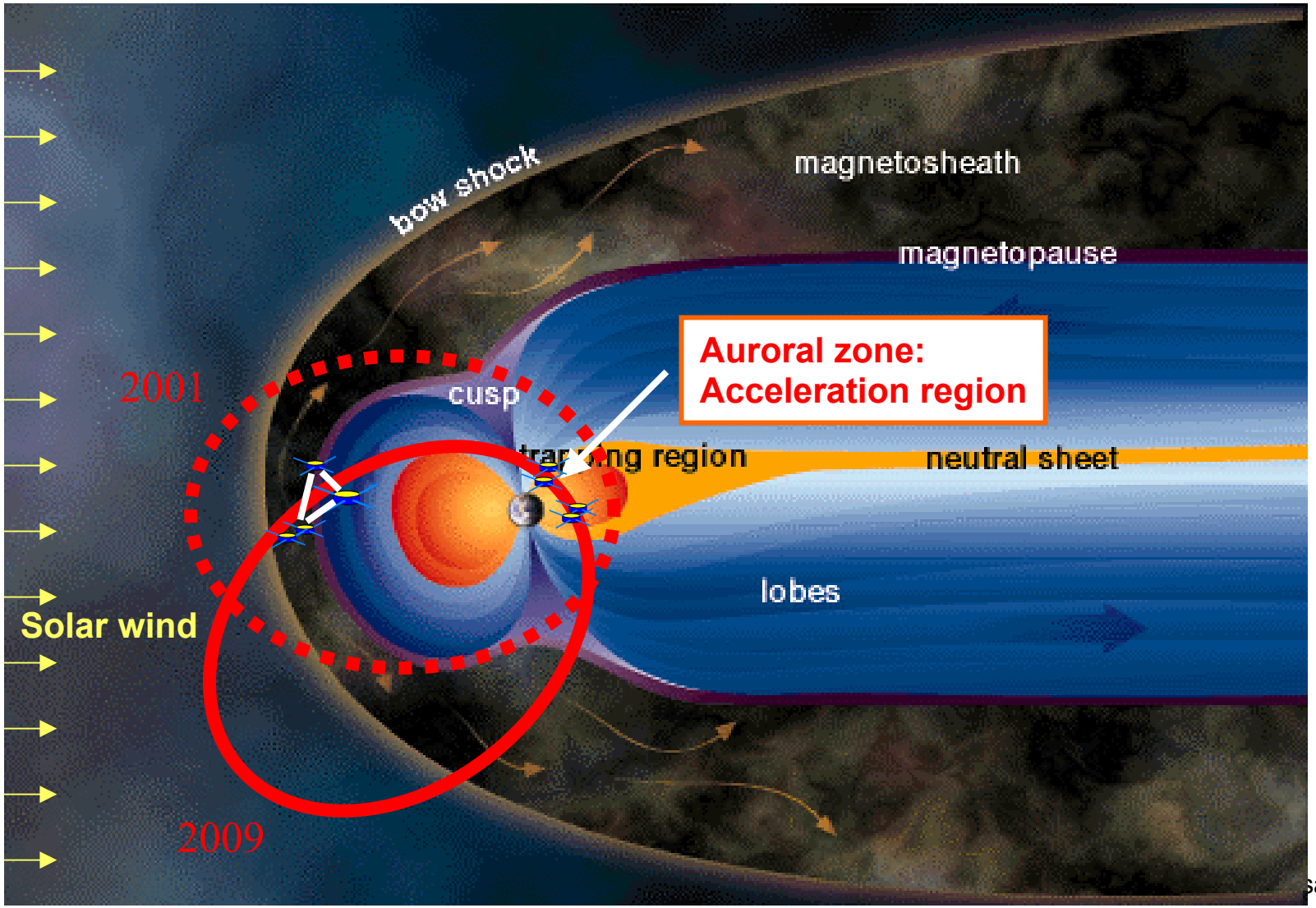


Key rationale for extension

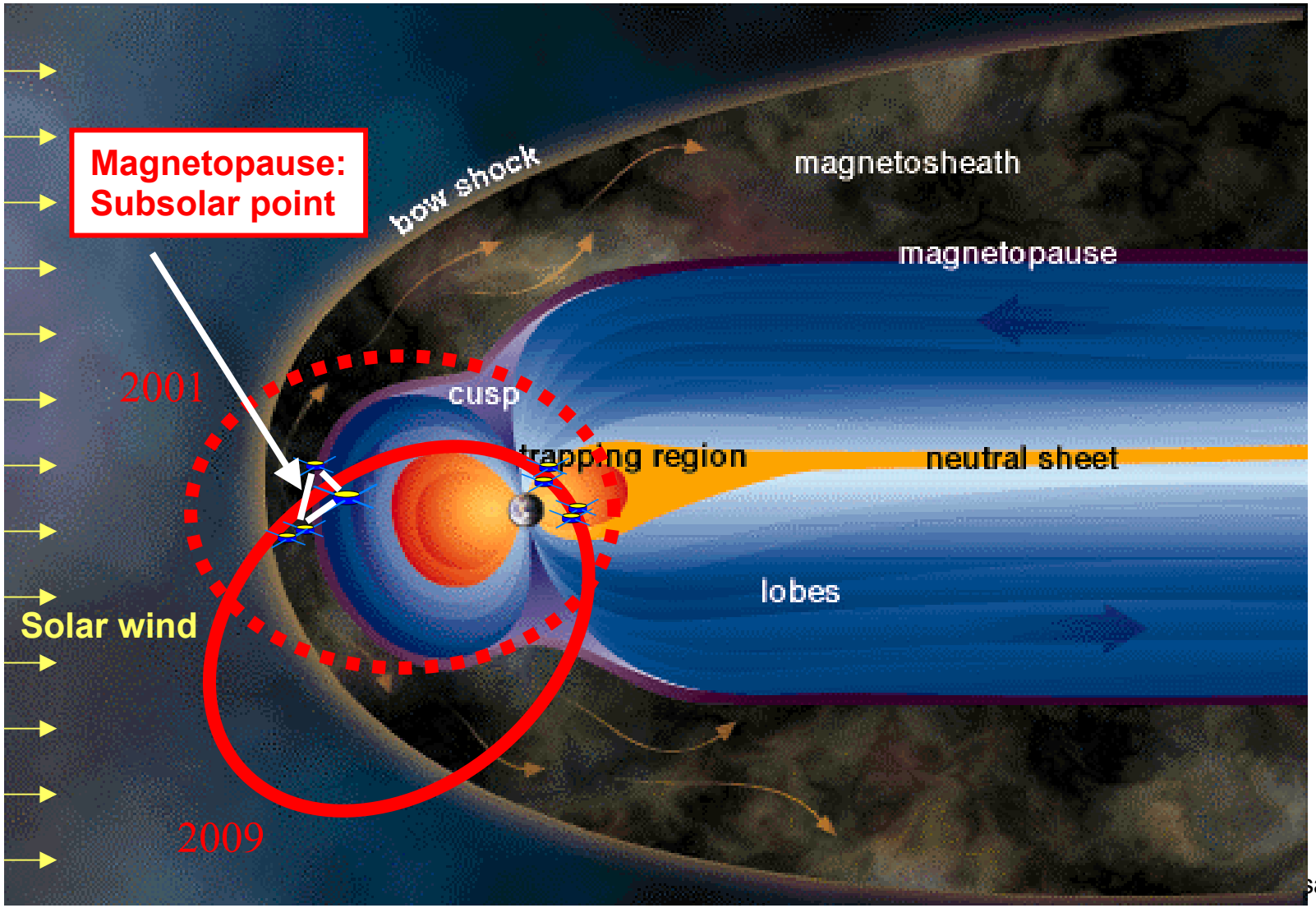
- *Mission extension: Jan 2006 – Dec 2009 (2+2 years)*
  - need to explore also the **polar cusp/solar wind at large (10000 km) s/c separation**
  - start a new s/c configuration phase allowing for **adaptive** or **multi-scale/multi-orientation observations** and
  - visit **new magnetospheric key regions,** never visited by multi-spacecraft missions (Cluster) before

Hermann.Opgenoorth@esa.int

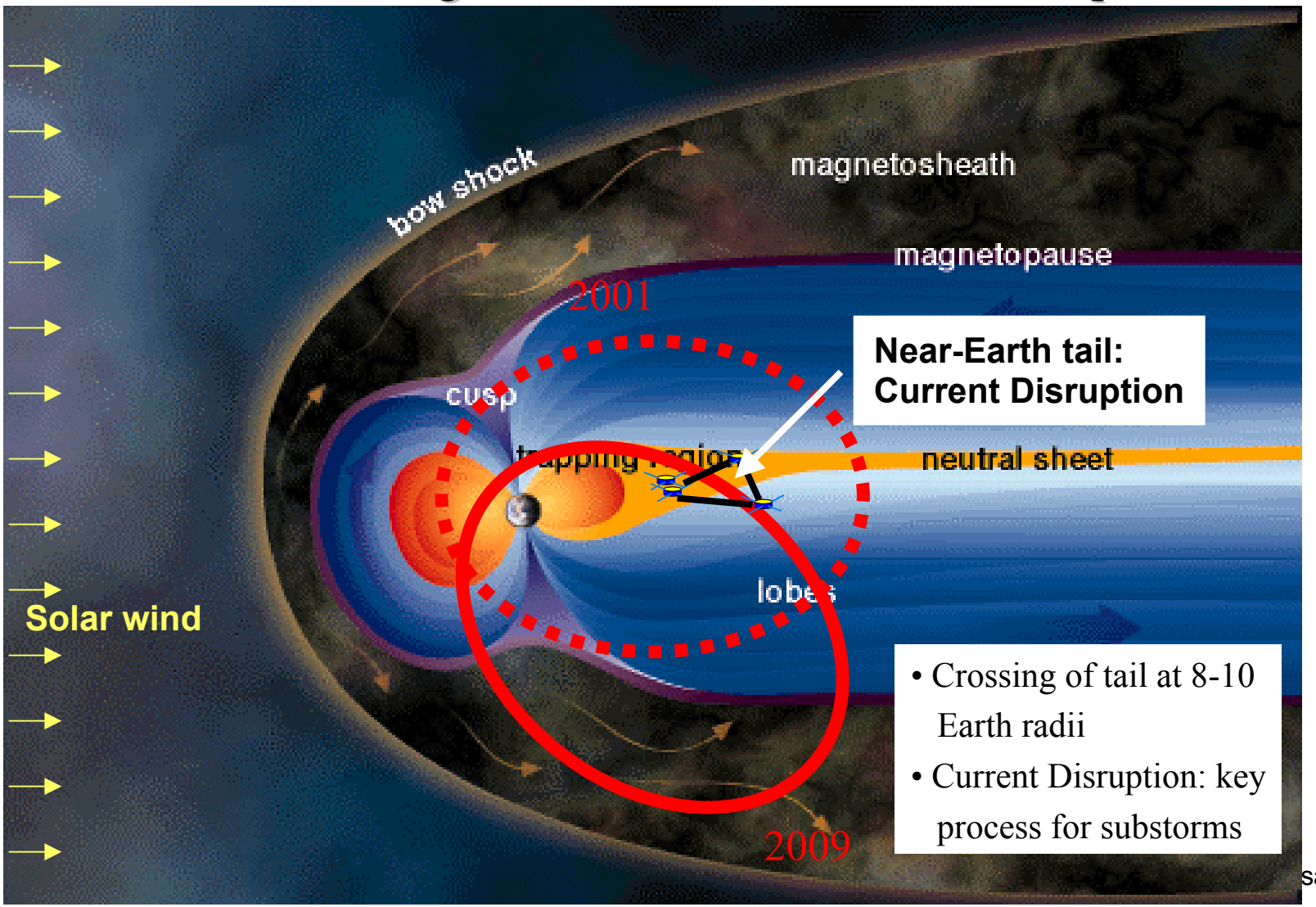
Cluster new regions: subsolar point and auroral acceleration

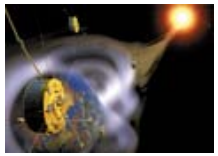


Cluster new regions: subsolar point and auroral acceleration



Cluster at new region: Near-Earth Current Disruption





Cluster 2nd Extension - not "*more of the same*"

- **New adaptive spacecraft configurations** possible
- **New orbit** development by "degradation"
- Visit to **new key regions** possible
- Collaboration and complementarity with **Themis**

=> **New unexpected science** can & will be done !

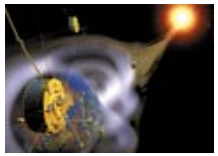
Bonus:

- Valuable input to new multi-scale science and future **mission planning for MMS, M^3, SCOPE** etc. (see Themes in Magnetospheric Science of the Cosmic Vision 2015-2025 draft)

Hermann.Opgenoorth@esa.int

European ILWS Strategy in an Overview

	Major ESA Support or ESA – led	Modest ESA Support	Strong ESA endorsement
1 Sun and Solar Wind Energy Source	Soho & Ulysses ext. **Solar Orbiter** BC–MMO SolarSent.	Solar – B grnd. stat. Coronagraph Stereo grnd. stat	L1 mission(s) Solar - ISS Proba - 2
2a Ionosphere - Thermosphere Energy deposition	**Swarm**	To be identified	Demeter Ravens - Kuafu
2b Magnetosphere Energy conversion	Cluster / DSP extension **M 3 development**	NLM's candidates tbi	Orbitals - RBSP Frisbee National Multi-Satell.
3 Sun and Climate End-to-End Observ.	–	TSI M of Opp / C-Ph Picard & Earthshine	–
4 Data Exploitation, Analysis & Models	Cluster Active Archive (CAA)	SDO DB or EN-SVO Stereo / Solar–B GrSt	Model and Theory Space Weather / GB



CLUSTER

Hermann.Opgenoorth@esa.int